Report for 2005MI60B: Evaluation of Low-Disturbance Tillage in Mitigating the Transport of Bacterial Contaminants from Land Applied Dairy Slurry to Subsurface Drains

Publications

- There are no reported publications resulting from this project.

Report Follows

Project Number: 2005MI60B
Start: 03/01/05 (actual)
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Reporting period: 1/1/05 to 6/30/06
Title: Evaluation of low-disturbance tillage in mitigating transport of bacterial contaminants from land applied dairy manure to subsurface drains.
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Focus Categories: Agriculture, Water Quality
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Abstract
Twelve instrumented flumes with sampling ports were installed in subsurface drains at a three hectare site in a Blount loam soil on a dairy farm in the Raisin watershed in Lenawee County, Michigan. A low-disturbance rolling-tine aerator and a subsurface manure slurry deposition system were used to apply liquid dairy manure in large replicated plots (no manure, manure, and manure plus desiccated cereal rye cover crop) 56000 L/ha. Drainage effluent was sampled and analyzed for total fecal coliforms and E. coli before manure application, two hours after application, two days and 16 days after application. The site received 24 mm of precipitation between manure application on May 1 and the two-day sampling event on May 3, and an additional 53 mm between May 10 and May 16. No fecal coliforms or E. coli were detected in pre-application samples. Two hours after manure application a low level of fecal coliforms and E. coli (<10 C.F.U. per 100 ml) were detected in effluent from manured treatments.

Objectives

The overall goal was to develop guidelines for environmentally sensitive application of livestock slurry on artificially drainage farm land. Specific objectives were to evaluate the bacteriological water quality of:

- Spring manure slurry deposition over aeration tillage slots in a no-till cropping system.
- Spring manure slurry deposition over aeration tillage slots and a desiccated, fall-planted cereal rye cover crop in no-till ground.

Methods and procedures

Twelve circular flumes with water sampling ports were installed in subsurface drains at a 3 ha site in a predominately Blount loam soil (*Fine, illitic, mesic Aeric Epiaqualfs*) in Lenawee County, Michigan (42.16º N, 81.06º W) in a long-term, no-till corn/corn silage/soybean cropping system. The subsurface drains (20 cm diameter, 15 m spacing, 0.9 m depth) were installed in 1995. A cereal rye (var. Wheeler, 125 kg/ha) cover crop was direct-drilled in a 9.8 m wide swaths centered in portions of the field on October 10, 2005. On April 14, 2006 the cereal rye cover crop (approx. 15 cm top growth) was sprayed with glyphosate (1.8 L/ha A.I.) to facilitate planting of soybeans in early May.

All treatments were pre-tilled with a rolling-tine aerator (3.66 m; Aer-Way, Holland

Equipment Ltd. Norwich, Ontario, Canada)[1] prior to manure application. The aerator was rear-mounted on a commercially available slurry tanker (11,340 L; Husky Mfg., Alma, Ontario, Canada) and was equipped with a SSD (sub-surface deposition, Holland Equipment Ltd. Norwich, Ontario, Canada) slurry distribution system (Fig. 1). The angle of the tillage tool shaft was set at 2.5º to fracture the soil yet minimize surface roughness at planting. No additional seedbed tillage or soil firming was done.

The aeration tillage tool and slurry tank were drawn behind a 112 kW tractor at 4.8 km h^{-1}. The manure slurry (56,000 L/ha) passed through a chopper/distributor (300 RPM) with radially configured outlets and was placed over the aeration slots in the fractured and loosened soil behind each set of rolling tines.

Figure 1. The manure slurry was applied at 56,000 L/ha following aeration tillage to loosen the soil and improve infiltration.

Samples of the drain effluent were drawn from each of the sampling wells on May 1 (prior to manure application and again two hours after application), May 3, and on May 16. The samples (125 ml) were drawn with a peristaltic pump and stored on ice in a closed container. The sampling tube was sanitized by circulating a 10% solution of sodium hypochlorite through the tube, allowing continuous contact for 10 minutes and double rinsing. All samples were processed within 24 h.

Water samples were analyzed using standard membrane-filtration methods (APHA, 1998) for detection of fecal coliform (FC) bacteria (mFC medium, Difco, Detroit, MI) and *Escherichia coli* (NA-MUG medium, Difco). All media was prepared according to manufacturer's instructions. For each water sample 50, 5 and 0.5 mL volumes were filtered though a 0.45 micron nylon membrane filter that was transferred to mFC medium and incubated at 44.5 ºC for 24 hr. If growth was uncountable at these dilutions further 10-fold serial dilutions were made to obtain countable growth. Bacteria enumeration was based on preparations with between 20-80 colonies, or calculated from multiple dilutions in the case of non-ideal counts. Following enumeration of FC colonies, the filter with the appropriate range of colonies was transferred to NA-MUG medium and incubated at 37 ºC for 4 hr. Fluorescent colonies were counted as *Escherichia coli*.

Statistical Analysis

The experiment was a randomized complete block design with four replications and three treatments (no manure, manure, and manure over a desiccated cereal rye cover crop). The null hypothesis of no difference in the median values of the bacteriological water quality of the drain effluent among treatments was tested with $\alpha = 0.05$ using the Friedman test in XLSTAT 2006 statistical software (Microsoft Corp., 2006). Multiple comparisons between the levels of factors to obtain significant differences for all pair-wise differences were conducted using Dunn's procedure (Dunn, 1964).

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[1] Mention of trade names, proprietary products, or specific equipment is intended for reader information only and constitutes neither a guarantee nor warranty by Michigan State University, nor does it imply approval of the product named to the exclusion of other products.

Results and discussion

No *E. coli* or fecal coliform bacteria were detected in the pre-application water samples. Low levels (≤ 1 cfu/ml) were detected in the manure-applied and control treatments two hours after sampling, but concentrations were below Michigan standards for full body contact. The May 3 samples were drawn following 23 mm rainfall in the previous 24 h (Fig. 2). Low levels of *E. coli* and fecal coliforms were detected in two of the control treatments indicating either a hydraulic connection between the no-manure control and one of the manure treatments, or contamination of the control from natural sources.

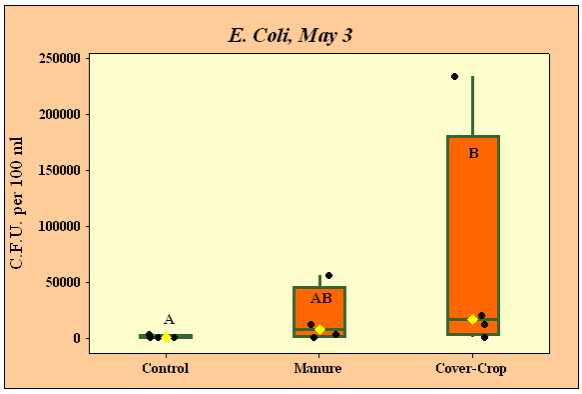

Figure 2. The E. coli concentration in the manure plus desiccated cover crop treatment was significantly greater than the no-manure control two days after manure application.

Although the treatments receiving aeration tillage plus manure tended to have greater levels of *E. coli* and fecal coliforms, the manure treatment was not significantly different from the control. The manure on a desiccated cereal rye cover crop was significantly greater than the no-manure control ($p \leq 0.039$).

The microbiological quality of the May 16 samples indicated less than one cfu/100 ml *E. coli* in all treatments (Fig. 3). However, both manure application treatments were significantly greater than the no-manure control ($p \leq 0.039$).

Conclusions

- When aeration tillage preceded a controlled manure slurry application rate of 56,000 L/ha in no-till crop land in the spring prior to planting, the microbiological quality of the subsurface drain effluent did not exceed the Michigan standard for full body contact two hours after spreading.
- Manure slurry application with aeration tillage over a desiccated cereal rye cover crop lead to a statistically significant increase in E. coli and fecal coliform concentration in the subsurface drain effluent compared to the no-manure control.

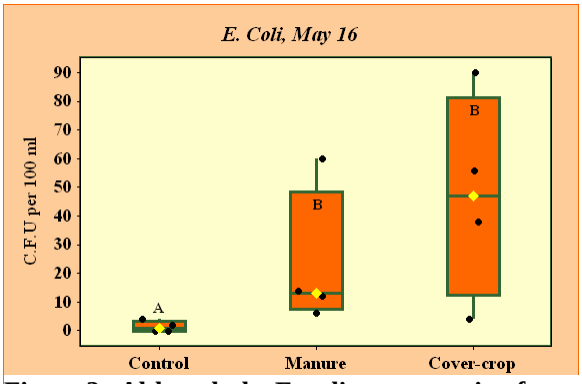

Figure 3. Although the E. coli concentration for all treatments were below the standard for full body contact, both manure-applied treatments were significantly greater than the no-manure control.